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DEFINING THE ENVIRONMENTAL PROTECTION INDUSTRY

Prepared for

The Policy and Planning Branch
Ontario Ministry of the Environment

and

Environment Canada

August 1987

ISBN 0-7729-2606-9

DISCLAIMER

The conclusions, opinions and recommendations expressed in this report are those of the consultant and do not necessarily represent the views of the Ontario Ministry of the Environment or Environment Canada.

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Foreword

The Institute for Research on Public Policy, Environmental Program, was the contractor for this project. A major part of the work involving the definition of the environment protection industry, and contact with industry associations was carried out, under sub contract by Energy Pathways Inc., Ottawa. Those participating in the study were:

Al Davidson	-	Environmental Advisor, The Institute for Research on Public Policy (IRPP)
Marjorie Loveys	-	Energy Pathways
Sandy Moroz	-	IRPP
Gary Floyd	-	IRPP
Randal Geehan	-	Professor of Economics, Carleton University

The conclusions and recommendations resulted from a team approach but the contractor takes responsibility for them.

Executive Summary

The advantages of defining an environmental protection (EP) industry are explored and a definition of the industry is presented and discussed. The idea of defining an industry has important positive policy implications.

Data currently available on EP as defined are reviewed. There are good data from Statistics Canada on government expenditures. Incomplete data on capital expenditure by industry are available from DRIE. Beyond that there are few comprehensive suitable data. It is suggested that economic impact and employment analyses carried out on the basis of existing data would be understated, vulnerable to criticism, and lacking credibility and should be postponed until better data are compiled.

A review is made of a number of possible approaches to gathering more complete data: first from EP purchasers by special surveys and then from suppliers of EP by both quantitative and qualitative special surveys; and then by Statistics Canada as part of its overall data program. The feasibility of these approaches is discussed and it is suggested that a program to obtain suitable data is feasible.

Economic analysis tools and the type and quality of EP data needed to employ them; and more particularly the types of analyses which could be carried out with additional suitable data, are reviewed.

Steps are recommended to achieve a common acceptance of a definition of the EP industry by all agencies collecting data; and to gather much improved data on the industry by way of Statistics Canada survey questions within their existing framework, and by special surveys. Finally, it is recommended that a longer term data collection plan be devised, with an appropriate lead agency, and that EP economic and employment impact studies be carried out when the first stage of improved data collection is reached.

RÉSUMÉ

Le rapport fait état des avantages qu'il y a à définir de l'industrie de la protection de l'environnement; il présente et examine ensuite une définition. Le fait de définir une industrie a des répercussions importantes et positives sur les politiques.

Le rapport étudie les données actuelles sur la protection de l'environnement telle qu'elle est définie. Il existe des données valables de Statistique Canada sur les dépenses gouvernementales. On peut obtenir des données, bien qu'incomplètes, sur les dépenses en immobilisations par industrie auprès du ministère de l'expansion industrielle et régionale. Outre cela, il existe peu de données exhaustives et pertinentes. Le rapport fait valoir que toutes les analyses des répercussions économiques et l'emploi seraient inadéquates et discutables si elles étaient basées sur les données existantes. C'est pourquoi elles ne devraient être effectuées que lorsque de meilleures données seront disponibles.

On examine diverses formules possibles pour recueillir des données exhaustives : d'abord auprès d'organismes/industries achetant des services de protection de l'environnement, au moyen d'enquêtes spécifiques, puis auprès d'organismes/industries offrant ces services, au moyen d'enquêtes quantitatives et qualitatives spécifiques, et enfin par l'entremise de Statistique Canada, grâce à son programme global de données. Les auteurs étudient la faisabilité de ces diverses formules et indiquent que, selon eux, il est possible de mettre sur pied un programme permettant de recueillir des données valables.

Le rapport examine les méthodes d'analyse économique, de même que le type et la qualité des données nécessaires sur la protection de l'environnement; il examine ensuite les analyses qui pourraient être effectuées avec davantage de données pertinentes.

On recommande certaines mesures pour que tous les organismes qui recueillent des données se mettent d'accord sur une définition de l'industrie de la protection de l'environnement, et pour que l'on obtienne de meilleures données sur l'industrie, que ce soit au moyen d'enquêtes spéciales ou par l'entremise de Statistique Canada. On recommande enfin d'élaborer un plan à long terme de cueillette de données soit élaboré en collaboration avec un organisme spécialisé en la matière et d'effectuer des études des répercussions cette industrie sur l'économie et l'emploi une fois franchie la première étape de collecte de données de meilleure qualité.

DEFINING THE ENVIRONMENTAL PROTECTION INDUSTRY

1.0 Introduction

The growing public concern about the state of the environment is leading to a great deal of activity throughout the economy. This activity, though popular with the public, is regarded by some as a cost to industry and government, in other words, as a load on the economy. However, it may also be viewed as an industry in itself -- the environmental protection industry.

"Environmental protection" has wider implications than the more familiar "pollution abatement and control" or PABCO: it also includes activities designed to prevent pollution. This industry has important economic impacts: in the supply of goods and services; in employment; in productivity gains and technological advances; and in exports.

Environmental protection in fact covers a broad range of activities such as environmental assessment studies, planning and consulting activities undertaken for the purpose of minimizing environmental damage, and engineering design, as well as monitoring and testing services which follow the installation of new facilities or implementation of new techniques.

All these activities, besides being important from a domestic point of view, are also of value as export commodities. The Task Force on Environmental Protection Technologies in a report to the Minister of State for Science and Technology observed in 1984 that ". . .the installation of (innovative environmental protection) technologies at home or abroad can provide earnings for

those who manufacture or service them. By solving problems at home, Canadians can develop skills, expertise and equipment that can also be sold abroad".*

All levels of government play a significant role in encouraging protection of the environment. As awareness of the problem increases, government regulations are becoming, of necessity, more stringent.

An adequate information base is a great asset in the design of sound regulatory activity. If the environmental protection industry could be described and defined, and if sufficient suitable data and information were available, as is the case in a number of other industries, then its impacts, its problems and potentials, and its trends and relationships with other sectors could be studied and the economic effects of environmental policy changes could be better understood.

This brief feasibility study, initiated jointly by the federal Department of the Environment and the Ontario Ministry of the Environment, is a first step in exploring this question. It is an attempt to define and characterize the industry and explore the data now available, review the application of economic analyses, and to recommend methods of collecting more useful data in the future.

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* Task Force on Environmental Protection Technologies. Report presented to the Minister of State for Services and Technology, Ottawa, February 1983.

2.0 Objectives

2.1 Short-term Objectives

The aim of the present study is to define the environmental protection industry; to review the currently available and potentially available data on it; to discuss the types of economic analyses which might be employed with suitable data; and to recommend how such data might be compiled.

The objectives in more detail were as follows:

1. To establish a basic definition that can be used in determining the activities which should be included in an "Environmental Protection Industry Sector" for the collection of statistics and the analysis of economic impacts.

2. To identify the types of data which will be required for the conduct of economic analyses and, further, to suggest the means and sources from which such data can be obtained.

3. To review data already available from Statistics Canada, other federal agencies and departments and industry associations, and comment on the applicability of these data.

4. To establish the feasibility of identifying the establishments which produce pollution control equipment and services in Canada.

5. To identify the types of activities, both modelling and non-modelling, that could contribute to the production of sound economic analyses.

6. As a final step, to refine the definition of the environmental protection industry to reflect the results of consultation with interested parties.

The conduct of this phase of the study is the subject of the present report.

2.2 Long-term Objectives

It is anticipated that the findings of the first phase of the study will form a basis for more comprehensive stages of analysis, with the following long-term objectives:

1. To define and describe the industry or, more precisely, the several subsectors which produce environmental protection goods and services in Canada. This should not only increase understanding of these subsectors on the part of government and other agencies, but also enable government to deal with them in the future as legitimate forces in the Canadian economy.

2. To provide a reliable measure of the environmental protection industry in Canada, with the aim of demonstrating its contribution to the economy, including production, employment, technology and trade.

3. To develop a plan and put in place a mechanism for long-term data collection in the area of environmental protection activity.

4. To develop a data base and a set of tools which will allow governments to predict the economic impact of regulatory changes on the producers and users of environmental protection goods and services.

5. To identify environmental protection goods and services which are currently being exported, as well as those viewed by industry as viable export commodities for the future.

6. To identify research and development activity and technology development, so that government might provide adequate support for these key activities.

3.0 Working Definition of Environmental Protection Activity

Following a series of meetings between the contractors and representatives from Environment Canada, the Ontario Ministry of the Environment and other interested agencies, the following working definition of environmental protection was formulated:

> Environmental protection includes any activity which has as its major effect the reduction or avoidance of emissions of materials that by virtue or their nature, quantity or quality are, or may become, detrimental to the environment.
>
> It also encompasses activities that enable the above activities to take place, such as public consultation on siting issues.

In the past, studies of this sector included mainly capital costs, and did not address the service component of the industry. The approach used for the present study represents a departure, since services are now viewed as an increasingly important element in the economy. In accordance with this view, the consensus of opinion at the meetings with the various agency representatives was that this study should consider services, such as engineering consulting and design, laboratory testing and monitoring, etc., as well as capital costs. Furthermore, it was decided to include both current-account expenditures (i.e., materials and services required to operate and maintain equipment) and own-account expenditures. (i.e., production of environmental protection capital equipment by a company for its own use and contributions made by the purchasing companies' own staff to the installation of equipment).

American Petroleum Institute figures, as published in a 1986 study by Management Information Systems, show that their members' costs on "O&M" are significantly greater than capital costs.* Thus the inclusion of current O&M expenditures is important in measuring EP economic activity.

The question of distinguishing between air, soil and water pollution was addressed in the early stages of this study. There is, from the ecological point of view, no reason to make any distinction -- contaminants emitted into the air will inevitably reach the ground and, ultimately, the water. However, these three areas tend to be regulated independently and, to a certain extent, different industries have evolved to deal with them. This is reflected in the breakdown of subsectors proposed later in the report.

There are a number of types of activity that are just beginning to develop. A few cities, including Ottawa, are studying locations where hazardous materials such as coal tar, have been previously stored, in order to protect any subsequent developer.

In addition there are some isolated instances of special activity on environmental protection at the municipal level. In a number of localities, municipal waste coordinators are appointed, usually within the planning or engineering department. Their duties include the organization of seminars and workshops for local industry on subjects related to environmental protection, and

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* Management Information Services, Inc. Economic and Employment Benefits of Investments in Environmental Protection, Washington, D.C., 1986.

the development of supporting information materials. This type of activity represents an area of possible future growth in expenditures, particularly in view of the increasing emphasis on the activities of smaller polluters, and on the role of the municipalities. These activities should be included in the definition of EP and efforts made to measure them if the level of activity increases.

It was recognized, in discussions with the contractors, that many other aspects, such as resource conservation, could have been included. However, it was agreed for this study that the following areas should be excluded from consideration, mainly to make the study more focussed.

- Energy conservation. Since the production of energy creates stresses on the environment, energy conservation invariably protects the environment. However, energy conservation is not done primarily for environmental protection reasons and was not included in the terms of reference of the study.

- Resource management activities in line with the definition set out above.

- Water purification. The economic ramifications of ensuring a potable water supply were considered to be of such magnitude that it merits discussion and analysis as a separate subsector. However, it was decided that this area does not fall within the working definition of environmental protection, but is rather a matter of health protection.

- Nuclear waste management. It was felt that this area should also be addressed as a separate issue.

- Noise abatement. Noise abatement technology does not fall within the terms of the working definition as it is predominantly a health protection issue. For this reason the issue is not addressed in the present study.

- Government enforcement and compliance, administrative overhead and policy-making.

4.0 Methodology of the Search for Data

Employing the working definition the study team undertook a data search.

4.1 Framework for Data Search

The consultative meetings which were held between contractors and clients included detailed discussion of the approach and sources to be utilized for collecting data on the environmental protection industry. It was agreed that the federal and Ontario Departments of the Environment would make available to the contractors copies of any relevant reports. Apart from this, the search would focus on the two most probable sources of data; Statistics Canada and the industry associations representing both the companies operating in the environmental protection industry and the companies who are major purchasers of environmental protection commodities.

The following is an overview of the types of activity which are included in this industry. Purchasers and suppliers of commodities were investigated separately. In each case the current availability of data was investigated, together with the potential for embarking on a data collecting exercise.

In addition to looking for data on environmental protection suppliers, a search was made for lists of companies who were identifiable as environmental protection suppliers.

The environmental protection industry is made up of firms that supply the goods and services listed in the section below. It excludes these firms which undertake the activities listed earlier as exclusions from the definition.

4.1.1 On the suppliers' side:

The following is a list of commodities -- goods and services -- which formed the basis for seeking information on the nature and scope of the industry that supplies environmental protection commodities.

Services

- Engineering and consulting, including resource planning, environmental impact assessment, public consultation (on the siting of pollution abatement and other facilities, for example) and project management.
- Waste treatment, disposal, exchange.
- Waste recycling.
- Solid waste handling.
- Liquid waste handling.
- Laboratory services, including environmental monitoring, waste assessment and evaluation, remote data gathering and automated control technologies.
- Contracted research and development.
- Biotechnology. This new subsector of industrial activity has the potential to become a major problem in the future because of the unique nature of its pollutants, which have a capacity for self-replication. However, it is not a significant waste producer at present. It does, however, offer the potential for providing significant environmental advantages through replacement of chemicals.
- Training, professional development and communications activities, including association seminars and conferences, industry seminars and workshops, and the development and production of information materials.

Products

- Equipment
  - for solid waste treatment
  - for wastewater and sewage treatment
  - for water pollution abatement
  - for air pollution abatement
  - other pollution control equipment
  - monitoring and resource recovery.

This may be built into new facilities, incorporated into existing facilities or "added on".

- Materials, including chemicals, filters, etc.

4.1.2 On the purchasers' side

The following is a list of classes of expenditures for which data were sought.

Municipalities

The existence of data on capital and operating expenditures was investigated for:

- Solid waste
  - collection and disposal
  - incineration
  - recycling
- Sewage treatment.

Private industry

Data on expenditures was sought for:

- Capital expenditure
  - instrumentation
  - plant modifications
  - process changes
  - "end-of-pipe" installations

- development of new products
- research and development
- own account contributions.

- Current expenditures
  - purchase of services (consulting, laboratory services, waste removal, treatment, disposal, etc.)
  - purchase of materials.

- Own-account expenditures
  - operation and maintenance
  - in-house expertise.

4.2 Published Reports

All available reports dealing with this sector were reviewed by the contractors, and an assessment was made of the usefulness and comprehensiveness of the data presented.

4.3 Data Search at Statistics Canada

While most of the expenditure data available in Statistics Canada's catalogues are referenced in earlier sources,* additional information was discovered. The knowledge and advice of several Statistics Canada officers and the descriptive summaries of Statistics Canada's catalogues contained in

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* Davey, T. and T. Bhagat, "A Survey of Financial Resources Devoted to Pollution Control and Environmental Protection in Canada", Water and Pollution Control, November/December, 1979, pp. 39-54.

Laikin, R. and J. Donnan, "Expenditures on Environmental Protection in Canada, 1980-84", in G. Ruggeri, ed., The Canadian Economy, pp. 238-242.

the Current Publications Index were helpful in this search. In addition, information concerning the content and quality of the data was obtained through discussions with Statistics Canada personnel and from the explanatory notes contained in the relevant catalogues.

Since no other known sources referenced production data from Statistics Canada, considerable time was spent searching for these data. Because the Standard Industrial Classification (SIC) system does not include an EP industry class, the production of EP goods and services is subsumed under a number of industry classes. Hence, the first approach involved searching the SIC manual for the industry classes containing (specialized or non-specialized) EP goods and services. The second approach involved searching the Industrial Commodity Classification (ICC) manual for the commodity groups defined as environmental protection goods or containing EP goods.

4.4 Data Search: Industry Associations

A comprehensive list of industry associations representing companies across Canada which use and produce environmental protection goods or services was compiled. The service component of environmental protection activity was well represented, i.e. engineering design, technology transfer, training, research and development, environmental impact assessment and monitoring, etc.

A telephone canvass of a cross-section of the industry associations included in the above-mentioned list was undertaken. Most association

representatives were very cooperative and were willing to enter into detailed discussion. In view of restricted time and resources, the contractors felt that telephone communication with a representative group would yield sufficient information for conclusions to be drawn about the nature of data collected by associations and the approach which would be needed to generate more comprehensive data in the next phase of the study.

4.4.1 Data Search: Purchasers

Discussions with purchasers of environmental protection equipment and services focused on whether member companies make a practice of compiling data on expenditures in this area and, if not, whether they would respond to a survey designed to generate such data. The following associations were contacted:

Canadian Pulp and Paper Association

Canadian Manufacturers Association

Canadian Petroleum Association

Auto Parts Manufacturers Association

Motor Vehicle Manufacturers Association

Federation of Canadian Municipalities

Canadian Mining Association

Lambton Industrial Society

Petroleum Association for the Conservation of the Environment (PACE)

Canadian Steel Environmental Association

Canadian Chemical Producers Association

In view of the striking degree of consistency in the opinions stated and the information gleaned from this exercise, this was felt to be an adequate number of contacts.

4.4.2 Data Search: Suppliers

Discussions with associations representing producers and suppliers of environmental protection equipment and services followed the same lines. However, information on the scope of the membership was stressed, and enquiries were made as to whether associations would be willing to provide their membership lists. Again, the consistent pattern of response led the contractors to conclude that it was not necessary to contact all associations listed. The following associations were contacted:

The Ontario Society of Environmental Management

The Ontario Liquid Waste Carriers Association

The Canadian Water Systems Manufacturers Association

Association of Consulting Engineers of Canada Recycling Council of Ontario

Ontario Pollution Control Equipment Association

The Air Pollution Control Association (Ontario section)

Ontario Waste Management Association

Pollution Control Association of Ontario

Canadian Association of Recycling Industries

Environmental Industries Council (U.S.)

4.5 Data Search: Discussions with Provincial Representatives

Representatives of the provincial governments of Ontario, and British Columbia were approached, since these provinces engage in tracking environmental protection activity to some extent.

Discussions with the Ontario Ministry of the Environment centred on applications for Certificates of Approval for pollution discharge; with the B.C. Department of the Environment the more general aspects of environmental assessment, review procedures, etc. were discussed.

5.0 Findings of the Search for Data

5.1 Data Framework for Economic Analysis

In order to evaluate the existing data -- and to determine how and where additional data should be collected -- it is useful to outline briefly the general data framework of economic analysis. At the most common or simplest level, an economic activity is defined and measured in terms of a commodity. A commodity can be either a good or service. There are fundamentally two sides to economic activity: the supply side and the demand side. The data on the supply side describe the economic characteristics of producing and delivering the commodity, while the demand side describes the economic characteristics of purchasing and using the commodity.

At the base of the data framework is the concept of a commodity. It links the demand side to the supply side, and acts as the hub around which the other data concepts are defined, and data are collected. A commodity itself can be defined and described in many ways and along various lines but the usual approach is to identify it in terms of some chief general functional characteristic. As discussed below, this can create problems when a commodity defined by its main functional characteristics can be applied to many particular uses. For example, a pump is defined by its main function which is to propel substances, and can be further distinguished by the type of substance air, water, etc. it intended to move. However, it becomes more difficult to separate air pumps used for environmental protection from those which are used for some other purpose when the actual pump itself is the same in terms of its physical and functional characteristics. This is not to say that data on environmental protection air pumps cannot be collected.

However, as the degree of detail used to define a commodity increases, the effort and cost required to compile meaningful data becomes greater.

On the supply side, the most basic pieces of economic data on a commodity are the value and quantity of domestic production. However, in undertaking economic analysis other types of data and information are required, such as how the commodity is produced, and where; how producers make the commodity, how many poeople are employed in producing it, etc. Data describing the production of a commodity are gathered on the basis of industries, and an industry consists of establishments or operating units engaged in the same production activity in terms of the commodity or group of commodities produced. (The term "industry" is preferred to the term "sector" because the latter term is commonly used within the national accounts to divide economic activity into government, government business enterprises, private corporations, households, and non-resident sectors.)

By definition, an establishment is the smallest operating unit able to report basic production statistics such as sales or shipments, employment, material inputs, etc. An establishment may be an entire corporation, a manufacturing plant, a corporate division, a retail store location, a branch office, etc. Under the Statistics Canada data framework, each establishment is allocated to an industry in the Standard Industrial Classification (SIC) on the basis of its major activity as defined by the commodity, however widely or narrowly specified, that contributes the largest share of the value of production by that establishment. For example, a plant may produce bulk chemicals and plastics. If plastics production constitutes the major activity in value terms, the establishment is allocated to the plastics

industry, although the output data reported for that industry will include both plastics and chemicals. If a corporation has separate plants producing synthetic fibres and bulk acids, the two establishments may be allocated to different industries. Much of Statistics Canada's data on employment, sales, value added, etc. are organized by industry in this way.

With regard to supply-side data available from Statistics Canada, as a general rule data are reported along two lines. Data are available on the total value, and sometimes the quantity, of domestic production of manufactured goods -- but not services -- on the basis of the commodities defined under the Industrial Commodity Classification (ICC) system. The degree and detail of the ICC data vary considerably across types of goods. For example, data for some classes of goods are broken out in considerable detail under the ICC system while data on other classes are available only at a broad or aggregate level. Data on the total value, and sometimes quantity, of imports of goods -- but not services -- are compiled on the basis of the commodity definitions under the Import Commodity Classification (MCC) system. Likewise data on exports of goods are available under the Export Commodity Classification (XCC) system. As with the ICC system, the degree of detail and disaggregation of goods classes varies significantly across classes under both the MCC and XCC systems. However the three systems can be linked together to provide data on domestic production, imports and exports of goods under a hybrid commodity classification system, which in turn provides a basis for economic analysis and the development of economic analytical tools.

The other form of available data is industry data, and a wide range of supply side data are reported in this form. Data on the value, and sometimes

quantity, of total shipments, purchased inputs, and other basic production statistics are reported for each industry defined under the SIC system. The SIC system includes both goods-producing industries and service-producing industries, although the degree of detail and reliability is greater for the former.

In addition to reporting data on the basic production statistics for each industry, Statistics Canada also provides a commodity breakdown of both the inputs used and the outputs shipped. Although the degree of commodity detail reported for each SIC industry varies considerably, the commodity data for goods in the SIC system can be linked to the commodity data in the ICC system. This allows data on imports and exports to be transformed from a ICC-MCC-XCC commodity basis to a SIC basis.

The links across classification systems also provide one measure of the magnitude of the domestic demand for a commodity on the output of an industry. If changes in inventories are ignored, then domestic consumption of an industry's output or of a commodity can be measured as domestic shipments (production) plus imports minus exports and re-exports. However, other more comprehensive data describing the demand-side are also part of the data framework.

Statistics Canada collects data directly on expenditures by sector (consumers, investors, importers governments, etc.) source (domestic, imported, province) purpose (clothing, food, construction, material inputs, research and development etc.). As in the case of industry and commodity data on the supply-side, the scope, coverage and detail of sector and/or

purpose are defined and limited on the basis of the expenditure classification systems established by Statistics Canada and other public agencies. Nevertheless, expenditure data are available for both the private and public sectors along a wide range of purposes, including various types of investment, and current purchases.

For the purposes of this report, it is relevant to note that expenditures for various purposes can be distinguished between expenditures by industries and by levels of governments. It is also possible if data are available to organize the data to estimate the source of the purchases for these expenditures, to link expenditures with a variety of descriptive demand-side variables, and to link expenditures with supply-side data.

The above discussion outlines the basic data framework for economic analysis. As Statistics Canada is the main agency for collecting data, the data framework for economic analysis is largely set by the framework used by Statistics Canada to collect, assemble and report data. The discussion has not been exhaustive; either in terms of the strengths and weaknesses of the framework or potential for assembling and organizing the data in different ways. It is, however, important to recognize, for the purposes of this report, that data collected on the basis of this framework constitute the starting point for further quantitative economic analysis of an activity. In a fundamental sense, these data are "basic data" in that they are required in order to develop estimates of other types of data that describe economic relationships. For example, basic data on the price and quantity of a commodity, the prices of other commodities, and the level of disposable income, are required before a simple estimate of the price elasticity of

demand can be obtained. The above framework outlines the form of basic data available for obtaining estimates of economic characteristics and relationships and for conducting economic analysis.

The discussion to this point has been general, and has not dealt specifically with the question of data availability for environmental protection activities. However, if the existing data on environmental protection are to be assessed, new data collected and/or economic analysis undertaken, this framework must be respected.

5.2 Analysis of Available Data

5.2.1 Published Reports

Few of the published reports yielded much relevant information. Many are purely narrative in nature, and where data are presented, they usually use data readily available from governments. Consequently these reports deal almost exclusively with capital costs and omit expenditures on services or research and development. Furthermore, little of the information is up-to-date, and most tends to be regional in scope. An annotated bibliography listing these reports will be found in Appendix A.

5.2.2 Data Available from Government Agencies

No government agency collects or publishes data on EP activity as it is defined in this report. Nevertheless, considerable data are available on the expenditures made by the users of EP commodities

(hereafter referred to as expenditure data) and some data are available on the commodities produced by EP suppliers (hereafter referred to as production data). The expenditure data, which are collected by several government agencies -- Statistics Canada, DRIE, Ontario Ministry of the Environment, Revenue Canada -- and defined somewhat differently -- e.g., PABCO, pollution control -- are reviewed in subsection (i). The production data, which are only collected by Statistics Canada, are discussed in subsection (ii).

(i) Expenditure Data

In general, data for public sector expenditures are relatively good; they cover most of the components of environmental protection activity and have no apparent biases. Private sector expenditure data, on the other hand, cover only a few components of capital outlays, and may contain biases for reasons which will be discussed later.

Data Available from Statistics Canada

Table 1* lists the Statistics Canada publications in which the available expenditure data can be found for both the private and public sectors.

Table 1 also shows the items covered in each catalogue, the relevant breakdowns of those items, and the sources of the data. Except for the data on construction work purchased, which are from Construction in Canada, and the capital expenditure data, which are from Corporation Taxation Statistics, the data are actual expenditures taken from the various sources indicated.

*See Appendix B

The data on construction work purchased come from capital expenditure surveys of business firms, institutions, government enterprises, ministries and departments.*

The private sector capital expenditure data come from the accelerated capital cost allowances (ACCA) granted to firms for air and water pollution control equipment. Since these data are collected by Revenue Canada, comments concerning the quality of them appear later in this chapter in the Discussion of Revenue Canada Data.

Statistics Canada, in its 1985 Capital Expenditure Survey asked companies to report capital expenditure on pollution control. The data will be available in March 1987 but will be subject to the following general weaknesses:

- no definition or guidance was given on what to include;
- no data on what commodities were purchased;
- no data on current expenditures; and
- no data on services.

Despite these weaknesses, these will probably be the best data available on private sector capital expenditures.

Table 2** gives a breakdown of the available data on environmental protection expenditures. At the local level of government, total expenditures are broken down into their current and capital components. For the other levels of government, however, only total expenditures are reported.

* See Statistics Canada, Construction in Canada, 1986, pp. 81-82.
** See Appendix B

Public Sector Expenditure Data

Statistics Canada publishes most of its data on public sector expenditures according to the expenditure categories defined in The System of Government Financial Management Statistics (FMS).* Four of these categories, which are listed in Tables 1 and 2, include EP expenditure made by the public sector. However, two of these also include other non-EP expenditures.

Although the content of the FMS "sewage collection and disposal" and "garbage and waste collection and disposal" categories listed in Tables 1 and 2 conforms with the definition of EP activity in this report, the other two categories listed in the tables, "pollution control" and "other environment", are not described in sufficient detail to indicate the proportion of these expenditures that are actually related to EP.

"Pollution control" is defined in the FMS to include "expenditure on the prevention of pollution and on obviating its detrimental effects on the environment, but only where such expenditures cannot be allocated to a more specified sub-function" such as "garbage collection and disposal".

"Other environment" includes "miscellaneous expenditure relating to the environment function which cannot be identified with any specific sub-function or which applies to several sub-functions".

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* Statistics Canada Catalogue 68507E, The System of Government Financial Management Statistics, 1984 and supplement 1986.

Although it is possible that these two categories cover expenditures by government to monitor pollution activity, clean up spills and maintain emergency clean up facilities and personnel, many other expenditures not related to EP may also be included. The administrative expenditures of the various ministries of the environment, for example, fall outside our definition, but are included in the "other environment" category.

Unfortunately, Statistics Canada employees in the Public Institutions Division could not provide any more detail on these categories other than that given in the FMS.

According to the FMS, research and development expenditures by all levels of government are included in two of the four EP expenditure categories shown in Table 2. While the "sewage collection and disposal" category includes grants and subsidies for research devoted to sewage problems, "pollution control" covers "outlays on general research and control activities".

It should be noted that Statistics Canada also publishes some EP expenditure data that are not organized according to the FMS. Also listed in Table 2, these include the research and development expenditures of the federal Department of the Environment and the public sector expenditures to construct sewage systems, disposal plants and connections. These data provide more detail on public sector EP expenditures, but because they are subsumed in the above mentioned FMS categories, overall data coverage is unaffected.

Private Sector Expenditure Data

Unlike the situation with respect to public sector expenditures, there are no comprehensive sources of private sector expenditure data. However, as is shown in Table 2A,* there are a few sources that provide some private sector capital expenditure data.

Statistics Canada has data on the private sector construction of sewage systems.

Data Available from other Government Agencies

The Department of Regional Industrial Expansion (DRIE) report provides data on capital expenditures for pollution abatement by large corporations during the years 1979 to 1985. Of the 274 large corporations surveyed for the 1985 report, 69 reported some capital expenditure for this purpose. Because current expenditure and services are not reported, and smaller firms are not included in the survey, these data understate the actual amount spent. No definition of environmental protection is provided to survey respondents.

In the case of Ontario, Ontario Statistics is published annually by the Ministry of Treasury and Economics and contains information on the estimated capital costs of water and air pollution control facilities by the industrial sector in Ontario. Although some public environmental protection expenditures are also included, these data come from sources that are discussed elsewhere in this report. The data on private sector capital expenditure for water and air pollution control facilities are

*See Appendix B

costs reported by companies when applying for Certificates of Approval from the Ministry of Environment. However, the published figures are believed to understate the actual levels of expenditure for several reasons: some applicants provide only estimates, capital expenditures only are requested, and since their inclusion in the application is not mandatory, only an estimated 50% of applicants provide cost information. Moreover these estimates are not verified in any way by follow up.

The Ontario Certificate of Approval applications, therefore, while representing one of the more useful examples of data gathering on environmental protection in Canada, are not completely reliable sources of data.

Discussion with several representatives of the British Columbia Department of the Environment indicated that there is no organized effort to collect data in this area. Though considerable costs are incurred for environmental assessment, review procedures and preventive and mitigative measures, there is no quantification.

Quebec also has information from certificate of approval applications, and a good deal of other information is contained in departmental files. However, it is not published, is not hard data, and is not readily available.

It is apparent that provincial governments have no comprehensive source of data or coordinated approach to data collection in the area of environmental protection on the part of industry. A survey of

government sources would therefore not be an appropriate step to consider.

Revenue Canada has Accelerated Capital Cost Alliance (ACCA) data on air and water pollution control equipment; but these data are weak due to several factors:

- not claimed when a company is not in tax position to do so;
- only equipment for air and water pollution control are eligible; and
- some of the expenditure may be claimed from other write-off categories.

The data available on private sector expenditures are summarized in Table 2A.

In summary, while there are accurate and fairly comprehensive data on environmental protection expenditures by the public sector, the private sector data are incomplete and biased. The public sector reports actual amounts spent on environmental protection-related activity; while the private sector data cover only a part of capital outlays and are not that reliable.

(ii) Production Data

There are not much useful data available on the production of environmental protection goods and services. The main reason for this is that Statistics Canada does not identify environmental protection activity separately from other economic activities in its classification

systems. Statistics Canada neither defines an environmental protection industry class (or classes) in its SIC system nor defines an environmental protection commodity group (or groups) in its ICC system. Since Statistics Canada publishes production data --principal statistics, some commodity data --according to the SIC system and commodity data according to the ICC system, virtually no useful production data are obtainable.

Statistics Canada publishes industry principal statistics -- value of shipments, costs of materials used and cost and quantity of labour resources employed -- according to SIC industry classes. But because no environmental protection industry class exists in the SIC system, environmental protection commodity production is subsumed under other industries. Since these industries also produce other commodities, few of the principal statistics reported for these industries are useful. Data on the costs of materials used and the cost and quantity of labour resources employed are useless because they are not (and cannot be) disaggregated by the commodities produced in an industry. Only value of shipments data are, and thus offer the potential of being of some use.

Although at least twenty-one industries produce one or more environmental protection commodities according to the SIC mannual, data are published for only one third of these. Table 3* lists these seven industry classes and identifies the Statistics Canada catalogues in which value of shipments data are available for several environmental protection commodities.

*See Appendix B

Statistics Canada also publishes commodity data -- quantity and value of shipments -- according to ICC commodity groups.

Although no environmental protection commodities were located in our search through the ICC manual over and above those identified in our search through the SIC manual, more detailed information is available from Statistics Canada catalogues reporting data according to ICC commodity groups. As shown in Table 3, data on the two industry classes published in Other Machinery and Equipment cover more or less the same environmental protection commodities as those covered by the four commodity groups published in Products Shipped by Canadian Manufacturers. The ICC groups provide a finer degree of commodity disaggregation than that available via SIC classes.

However, much of these data are not useful because they cover mainly non-specialized environmental protection commodities. Such commodities are classified under a generic title that does not distinguish between the various purposes served by a particular commodity. Pipes are an example of such a commodity. The ICC system distinguishes between concrete and clay pipes, but does not differentiate pipes used to transport potable or storm water from those used to carry wastewater. Consequently, most of the commodity data shown in Table 3 will be useful only if they are further disaggregated by specific purpose in future Statistics Canada catalogues.

Finally, some information on EP activity in the household sector was discovered in The Special Trades Contracting Industry catalogue. The total value of construction output on septic systems through listed as part of the available production data, could be used as a measure of EP expenditures by the household sector. Since there are no data on purchases of EP goods and services by the household sector, this would increase the coverage of the available expenditure data.

In summary, there are virtually no useful data available on the production of environmental protection goods and services. There is neither an SIC industry class nor an ICC commodity group currently defined for environmental protection goods and services. Although the quantity and value of shipments data were located for a few specialized and non-specialized environmental protection goods, these data are aggregated with other goods in Statistics Canada catalogues.

5.2.3 Data Available from Industry Associations

The telephone survey of industry associations yielded a consistent view of the current situation. The overall picture which emerged was one of few attempts to collect data. However, though the associations do not feel that they have the resources to embark on a data collection program themselves, they would generally support a well-conceived effort to do so.

(i) Purchaser associations

With few exceptions the associations reported that no data are collected in this area. At present, only one association, The Canadian Pulp and Paper Association, canvasses its members on their expenditure on pollution control, and even this survey is restricted to capital costs. Operating costs are regarded as such an intimate part of processing that the bookkeeping is regarded as too complex and this has not been attempted.

Representatives of the automobile industry reported the existence of submissions on the costs associated with meeting increasingly stringent emission control standards, beginning in 1985. Transport Canada supplied an estimate of these costs, which was a modification of the industry's own estimate.*

Representatives of the other associations contacted stated that no data are requested from member companies. However, the general view is that more comprehensive data would be useful if an adequate framework for collecting them could be developed. One or two associations have already given some thought to a data-gathering exercise, but have apparently not made much progress in developing a suitable approach. Some associations expressed enthusiasm at the prospect of an opportunity to express their views through the medium of a survey.

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* Analysis of the Effects of Proposed Revisions to Light Motor Vehicle Emission Standards, Department of Transport, Ottawa, June 1985, and Analysis of the Effects of Proposed Revisions to Heavy Motor Vehicle Emission Standards Department of Transport, Ottawa, August 1986.

Questions such as following were asked by many respondents:

- How can capital costs for pollution control be isolated with accuracy?
- What proportion of the cost of implementing a process change should be allocated to environmental protection?
- What proportion of the operating costs of facilities built in part to provide environmental protection can be said to result from this activity?

Many associations expressed concern over the difficulty of isolating environmental protection costs, especially since pollution abatement equipment is now usually "designed into" new facilities. Estimates of the proportion of capital costs attributed to environmental protection, for example, were felt to be misleading, since they may include equipment which is neither designed for pollution control nor used exlusively for that purpose.

These issues and the lack of any guidance on what types of expenditures to include has led to industry scepticism with regard to the reliability of published figures. At present there are no guidelines on these distinctions and, if a survey is to be the chosen approach for data collection, this is an issue which needs to be discussed with all interested parties with a view to providing adequate guidance.

Current surveys, such as that undertaken by DRIE, are considered be of questionable accuracy, since environmental protection activity is not defined, and no guidance is given in quantifying the portion of costs attributable to such activity.

So far as Statistics Canada's data are concerned, some associations are of the opinion that they are of limited use -- even misleading -- and, consequently, that there is a need to rethink the present approach to data collection in this area.

(ii) Producer/supplier associations

These associations vary greatly in size and scope, from large organizations with several categories of membership (for individuals, companies, government departments, etc.), to very small associations, especially in the service sector. As in the case of the purchaser associations, virtually no data on sales of environmental protection commodities are available.

Some associations, such as those dealing with liquid waste hauling, do not have a national association, but only operate at the provincial level. Furthermore, some supplier associations are chapters of larger organizations based in the United States. Examples are the Air Pollution Control Association, which has chapters in Ontario, Quebec and the Prairies, and the National Solid Waste Association, which has three Canadian chapters (including the Ontario Waste Management Association). It is understood, however, that lists of Canadian members could be made available.

The fact that there is little industry association activity organized around EP commodities is not surprising given the nature of the industries and commodities involved. Much of environmental protection goods and services are

- produced by companies for whom environmental protection is only a portion of their business
- not unique to environmental protection applications.

To illustrate this one can note that preliminary Environment Canada research estimates that 567 engineering companies are involved in environmental protection activities, compared with the membership of the Association of Consulting Engineers of Canada of about 800: As it is unlikely that 5/8 of the engineering work done in Canada is for environmental protection, there are many firms for whom EP is a small portion of that business.

The Ontario Pollution Control Equipment Association representative who spoke to the authors estimated the membership of the OPCEA had the following characteristic:

- 10% were totally dedicated to the EP market
- 50% had roughly one half of their business in EP
- 40% had less than 10% of their business in EP

From another perspective, P.S. Ross in their 1975 report, "Market Potential For Pollution Abatement Equipment," prepared for the Government of Quebec, state that "the cost of equipment represents only 20% of the total investment of a (sewage)

treatment plant".*. Thus many, if not most companies on a list of environmental protection suppliers would have environmental protection only as part of their business. This also means that a large portion of the economic activity associated with environmental protection can not be put into a specialized supply industry.

5.2.4 Summary

Several gaps and weaknesses in the data can be identified:

- There are virtually no data available on the production of EP commodities. The value of shipments data are available for only a few non-specialized EP goods; and there are no data on services.
- There are no data on current (i.e. operating and maintenance) expenditures on EP activity by the private sector.
- Private sector capital expenditure on EP activity are not fully covered. The 1985 capital expenditure survey data will only partially remedy this.
- There are no data on expenditures on services.

In the collection of such capital expenditure data as are available no definition of environmental protection was given to guide respondents.

In brief, data on environmental protection expenditures in the public sector are quite accurate and fairly comprehensive. Data on

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* Ross P.S. and Partners, Market Potential for Pollution Abatement Equipment, page 53. Report pepared for the Quebec Department of Industry and Commerce, June 1975.

private sector expenditure include only incomplete estimates of capital expenditures.

With this picture of a relatively weak base of available data in mind, the study now turns to the question of economic analysis possibilities, and the data required for them.

5.3 Options for Economic Analysis

5.3.1 Organizing the Data

The depth of economic analysis, particularly quantitative analysis, which can be performed is governed largely by the availability of data on environmental protection (EP) activity. Even descriptive studies require data in order to establish the facts, and more sophisticated econometric analysis requires both comprehensive data for simulating the economic impacts of changes and descriptive data for setting out the framework and assumptions underlying the impact simulation.

For the purposes of discussion, five levels of analysis are distinguished: descriptive analysis, economic impact analysis, analysis of industry production technologyand market demand, cost/benefit analysis, and macroeconomic/general equilibrium analysis. Under each of these headings, data requirements and the usefulness of the analysis are discussed. First, however, it will be useful to quickly review the findings on environmental protection activity.

Economic analysis of environmental protection activity must respect the general framework for economic analysis. Within this framework industries produce more than one commodity. Commodities include both goods and services. Each industry uses more than one commodity as inputs in its production process. All commodities produced by the Canadian economy are used as intermediate inputs by other industries or go to final demand in the form of personal consumption, capital formation, government purchases, or exports. In addition, commodities purchased and used in the Canadian economy include imports.

With regard to environmental protection activity most environmental protection commodities are found either in intermediate goods and services or capital formation. That is, they are used to produce other goods and services. It is important to separate purchased inputs from internally-produced or own-account inputs. For example, capital used by an industry consists of purchases of capital equipment manufactured by other industries, purchased construction and other services produced by other industries, capital equipment produced directly by the industry itself for its own use and the capitalized value of the labour provided by the industry's own employees. A railway, for example, may produce its own rails and use its own employees to lay rail, and these inputs are referred to as own account contribution to capital formation.*

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* In this context, one point warrants special mention. Many analysts would argue that the reported value of own account activity understates the contribution an establishment makes to its own capital stock. To illustrate, a piece of EP equipment purchased for $1 million may require another quarter million of own-account labour to install and test, labour which is unlikely to be capitalized. Consequently, as in the case of most industries, the capital investment component of environmental protection activity is understated.

It is also clear from the discussion in earlier parts of the report that:

- The bulk of the economic activity associated with environmental protection cannot be related to a single supplying industry in the current SIC system, or to commodities in the ICC systems.
- Significant amounts of non-specialized commodity production should be included in environmental protection activity.
- Reported capital expenditure on environmental protection understates the true level of investment activity because it understates own account contributions.
- Own-account current expenditures (i.e. non-capitalized expenditure such as maintenance, operating costs, laboratory testing) on environmental protection are probably significant but their magnitude is unknown and they do not fit readily into an industry by commodity input-output framework (This problem is not unique to environmental protection industries.)
- In addition to capital expenditures on environmental protection, there are significant current expenditures on goods and services purchased as intermediate inputs from other industries. Most would be of an unspecialized nature such as chemicals; others would be specialized, such as consulting services.

This discussion now turns to the types of economic analysis that could be done on environmental protection activity.

5.3.2 Descriptive Analysis

At the most basic level, descriptive data are required simply to place environmental protection activity in perspective in terms of both its role and contribution to the economy and its own economic characteristics.

The need for descriptive data and analysis is twofold: to describe the basic economic characteristics of environmental protection activity and to use the data and factual information to undertake other levels of economic analysis as well as meaningful policy development. Descriptive analysis involves collecting data and information on the fundamental economic characteristics of commodities and industries, including how, where and by whom they are produced; how, where and by whom they are used and purchased; and so forth. For example, a complete description of environmental protection activity would include:

- Producer data. Which companies produce environmental protection commodities; are they the main activity of these companies; Are the companies small, medium, large or do they vary in size; Are environmental protection commodities produced in separate establishments or within one facility along with non-environmental protection goods; Are the companies foreign or domestically owned; Where are the companies located, etc.

- Production data. What is the value and value-added of producing environmental protection commodities. Is the production labour-intensive or capital intensive. How many people are employed. What types of labour skills are required; what are the sex, education, wage rates and other chief characteristics of workers in the industry. What material and capital inputs are required. What is the productivity and cost structure of production. How important are imported inputs in the production of environmental protection commodities.

- Market demand data. Who buys environmental protection commodities. What is the size, diversity and growth of the market for environmental protection commodities. Is the market(s) competitive, oligopolistic or monopolistic. How important are import competition; how important are exports, etc.

- Policy data. What laws and regulations have affected or are affecting the demand for and production of environmental protection commodities.

In principle the desired data on producers and products could be obtained from the producing/selling industry. However, as discussed earlier, the difficulty is that many commodities used in environmental protection activity are produced by a wide variety of non-specialized firms. A further impediment is that much of the expenditure on environmental protection activity is on non-specialized commodities, often not identifiable by the producer or seller as environmental protection. Statistics Canada would need to define more precisely environmental protection commodity classes before being able to undertake meaningful data collection and this process, a survey and compilation of results would entail much elapsed time. Thus, despite the difficulties, a useful short-term step would be to survey directly a number of identified producers of environmental protection commodities.

Descriptive data on the market for and use of EP commodities could be gathered from purchasers and users of such goods and services. Statistics Canada already collects data on total public expenditures related to environmental protection, and by mid-year 1987, there should be new data on total environmental protection capital spending by the private sector. In addition, the industry's that are major users of EP commodities are large and well-organized into associations, thus facilitating a survey. Therefore there appears to be greater short-term potential for gathering information and data on environmental protection activity from purchasers and users.

Data from such a survey when combined with the Statistics Canada data on expenditures, could be an important contribution to

understanding the demand side of environmental protection. In particular, a survey might produce data on own-account use and, at the same time, provide some useful insights into the supply side of environmental protection. However, a survey of purchasers and users would not likely provide data on employment, value-added, and other key production variables.

In sum, the need for descriptive data is fundamental both to other levels of economic analysis and to sound policy development. Even preliminary economic analysis of environmental protection activity requires some descriptive data if it is to be meaningful. Moreover, good basic economic data are required for estimating relevant economic parameters such as price elasticities, economies of scale, market concentration, etc. Estimates of these economic parameters also play an important role in other levels of analysis.

A special survey of either the supply-side or the demand-side of environmental protection activity could be an important short-term step, both for obtaining descriptive data to be used in economic and policy analysis and for developing approaches for a more systematic collection of data over time. However, for purposes of long-term policy and economic analysis, the best long-term course would be for Statistics Canada to collect data on environmental protection as part of its overall statistical activities.

5.3.3 Input-Output Analysis

Economic impact analysis is often done using an Input Output (I/O) model, such as Statistics Canada's highly detailed input-output model of the Canadian economy.* Data on either output by the EP producing industry or on the value of commodity expenditures by users of EP (the relevant alternative here) can be fed into the model, which is then able to produce estimates of the direct and indirect effects on various economic variables across all industries in the economy.

Direct effects refer to the impacts on the industries which produce the commodities in question. However, since these industries must purchase goods and services from other industries in order to produce these EP commodities, the impact is spread indirectly to other industries in a widening series of ripples. In addition to these direct and indirect inter-industry effects, there are induced impacts from increased consumer expenditure which result from any net additions to labour income. Overall, the I/O model produces estimates of direct, indirect and induced employment in person-years, wages and salaries, value added or contribution to GDP, and induced imports (i.e. the value of increased imports necessary to support the production plan).

This type of analysis offers good prospects in terms of the praticability and usefulness of results which could be obtained in the

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* Statistics Canada, The Input-Output Structure of the Canadian Economy, Catalogue 15-506E, Occasional.

near term with minimum data on the value of production or expenditure. However, I/O analysis does have limitation and the results are open to misinterpretation. For example, the direct, indirect and induced employment estimates generated by the model are often treated as net new additions to employment and therefore as a net benefit. This would only be true if there were no displacement of any of the labour from other employment, a condition unlikely to be met in practice, as every economy faces resource and other economic constraints. Likewise, I/O analysis does not take into account relative price changes and commodity substitution in intermediate and final demand that could arise from demand or policy changes, and consequently the results be could significantly misinterpreted. This is not to say that I/O analysis is not useful or appropriate but only that the I/O model, like any other analytical tool, has its strengths and weaknesses.

Another one of Statistics Canada's input-output models (the price model) permits analysis of the direct and indirect impacts on all commodity prices which result from the increase in price of a single commodity (e.g., oil) or the increase in operating costs of an industry (e.g., the effects of increased costs of pulp production due to EP policies). The assumptions underlying the I/O price model are rather restrictive, but some exploratory analysis might be useful in determining how costs and prices might rise throughout the economy if the price of environmental protection commodities increases.

Data requirements meaningful for I/O analysis are no more demanding than those required for reasonably complete descriptive analysis. In particular we require data on current expenditures by EP using industries in the private sector, in addition to the data which currently exist (or will soon exist) on capital expenditures in the public and private sectors and the data on government sector current expenditure. It would be desirable to improve the quality of data in terms of commodity detail and consistency of definitions across different surveys. It would be helpful if the major characteristics of firms producing environmental protection commodities were available. It would further be useful if the data on own account expenditures were improved, but this is a problem for all industries, not just those purchasing EP commodities, and therefore it may not be realistic to expect improvements in Statistics Canada data in this area soon.

5.3.4. Analysis of Industry Production Technology and Market Demand

It is often of interest to analyze an industry in isolation. For example it is of considerable interest to economists, industry managers and government policy makers to know the details of the production technology of an industry. Questions that can be addressed include: Are there increasing returns to scale; What is the trend in productivity; How are costs affected by increased input prices; How would commodity taxes or new regulations affect the industry.

Such questions are best answered by constructing an econometric model of industry production. To do so requires detailed and accurate

time series data on prices and quantities of all industry outputs and inputs, preferably at the level of the individual firm. Such stringent data requirements probably preclude consideration of this level of analysis for firms producing specialized EP commodities.

Similar analysis of production technology could, in principle, be applied to firms which use EP commodities. For example, one might wish to analyze the behaviour of pulp mill output in response to increased expenditure on EP. One would be interested in productivity defined narrowly to include pulp production and also productivity defined broadly to include reduced outputs of undesirable effluents. To do so would require data on outputs of effluents over time and also some measure of valuation to be placed on a unit of effluent.

5.3.5 Cost/Benefit Analysis

According to standard economic analysis, government programs, including environmental protection, ought to be justified in terms of a weighing of incremental social benefits against social costs. The cost side of this equation is probably easier to measure and consists, as a first approximation, of the purchaser expenditure data needed to perform the economic impact analysis discussed earlier. Furthermore, the identification of users of EP is the first necessary step in estimating the net benefits of these expenditures. The social benefits, apart from any net increase in employment, will consist largely of improvements to health and well-being plus the economic value of reduced damage to resources such as fish, wildlife and recreation facilities.

The most difficult data to estimate for a cost/benefit analysis are those concerning the social benefits. However, a less demanding analysis in the form of cost effectiveness may be practicable. This measures the value of programs in terms of the ratio of program costs to some quantifiable measure of output such as reduced amounts of effluent. Data requirements are less restrictive but the resulting measures can be misleading in that a reduction of effluents in one region does not create the same benefit as the same reduction in another region.

5.3.6 Macroeconomic/General Equilibrium Analysis

A detailed multi-industry, multi-sector econometric model could be employed to answer questions about the impact on the economy of changes in EP policies or the EP industry. Large, detailed econometric models are a numerical depiction of the economy as a whole. They provide a systematic empirical framework of demand, supply and policy relationships, based on statistical estimates of theoretical interrelationships between economic variables. Because of their internal consistency, they are able to take into account simultaneously the direct and indirect impacts across a wide range of economic variables, and in contrast to the input-output model, they incorporate directly resource and other economic constraints, and hence displacement effects and resource re-allocation effects. Depending upon the particular model, this empirical framework can be used to examine the impact of policy and economic changes on such economic variables as GNP, production, employment, consumption, investment, prices, imports, exports, government revenues and expenditures, etc. These models can

also be used to compare the impacts under varying assumptions about the policy change and/or the characteristics of the industry or the economy.

There are a variety of large econometric models for Canada, each differing in its construction, size, detail, coverage, economic characteristics, abilities and applications. It is common to distinguish between macroeconomic models and general equilibrium counterfactual models. Both types of models are general equilibrium models in that they depict the economy as a whole and take into account directly the interrelationships between economic variables. The two types of general equilibrium model differ in their basic construction and characteristics and in the types of questions they are designed to answer.

Macroeconomic models are constructed on time-series data and, as such, can be used to examine the impact of changes over time. These models were originally constructed to deal primarily with macroeconomic issues such as fiscal policy, monetary policy, consumption, investment, etc. However, while still emphasizing the macroeconomic features of the economy, most present-day macroeconomic models can be used to address a wide range of economic and policy questions. At the core of large macroeconomic models is an input-output structure which allows the empirical analysis to examine the impact of changes in one industry on other industries, or the impact of changes in economy or policy environment on an industry. For example, a well-built macroeconomic model can be used to assess quantitatively the impact over time of a change in government or private expenditures on environmental protection

goods and services; both the performance of a particular industry and the economy as a whole. Moreover, the impacts of different ways of financing the increase in environmental protection expenditures can be compared.

Nevertheless, despite their versatility, macroeconomic models, like any other tool, are better at answering some questions than others. For instance, even the larger models only break out the economy into 30 to 50 industry groups. Consequently, these models are not well equipped to deal with questions concerning the market and production structure of a particular industry or the impact on an industry of microeconomic policy changes specific to that industry. In most cases, the industry in question is part of a larger industry group, and the details of the particular industry are submerged in the data and specification of the larger industry group. This is not to say that macroeconomic models cannot be used to study industries, but their chief contribution is in providing answers as to how general economic policy changes affect the economy as a whole as well as the specified industries, or how changes in expenditures in one sector or a group of industries affect the economy overall. Overall macroeconomic models are better suited to dealing with questions about the operation and performance of the economy as a whole, as opposed to examining a specific industry. With regard to the EP industry, a macroeconomic model could be used to examine the impact on the economy of EP production and exports, or of purchases and investment in EP equipment and services.

The second type of model is the general equilibrium counterfactual (GEC) model.* These models are constructed by first specifying theoretically both the structure of demand and supply in each industry and the interlinkages between industries and sectors. To construct the empirical model, two sets of data are required: estimates of the relevant economic parameters describing the structure and interlinkages, i.e., supply and demand elasticities, elasticities of substitution, scale economies, market power etc. and performance data for each industry, i.e., output, inputs, employment, exports, imports, etc. The estimates of the relevant parameters are usually obtained from various sources and the model is constructed around performance data for a given year. As such, they do not allow the examination of economic impacts over time as in the case of macroeconomic models. Nor do they concern themselves with macroeconomic policy variables such as money supply and demand, overall tax revenues and expenditures, and so forth. Also, GEC models are usually constructed and simulated by assuming full employment and consequently are not designed to answer the questions regarding the impact on the overall level of employment.

The absence of macroeconomic properties in GEC models reflects their intended purpose. GEC models are designed to answer policy questions about resource allocation and efficiency in the economy. They are long-run, static equilibrium models and they compare the structure and pattern of supply and demand before and after a policy or structural

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* There are a number of these, e.g. Harris Queen's University, Canadian Equilibrium Trade Model.

economic change. A well-elaborated GEC model describes the structure of each product market and industry in considerably greater detail than macroeconomic models by taking into account directly such considerations as relative input costs, scale economies, market concentration, firm size, commodity and other input tax rates, and other costs and demand factors. Consequently, they can be used to assess the impact of policy-induced changes in relative prices -- for example, tariff or tax rate changes -- on production, value-added, employment and productivity within and across industries, and on national economic welfare and income distribution.

For example, if environmental protection inputs could be properly identified, a GEC model could be used to assess the impact of higher environmental protection input costs or an environmental protection tax. Alternatively, if an environmental protection industry can be specified, GEC models can be used to examine the impact of changes in the economic or policy structure of that industry, on both the industry itself and other industries and sectors.

When considering general equilibrium models, a number of points should be recognized. First, as indicated above, macroeconomic models are designed to answer different questions -- or similar questions from a different perspective -- from GEC models. Second, even within the group of macroeconomic models, each existing model differs in detail, construction, fundamental economic characteristics and properties. Consequently, the answers to the same question may vary significantly between macroeconomic models. The same is true for GEC

models. Third, the construction of general equilibrium models is an expensive and time-consuming exercise. It is far better to employ an existing model and devote the effort to incorporating and specifying the presence of environmental protection activity within the model.

The types of data required for undertaking economic analysis, depend largely on the approach and the particular questions to be answered. With general data on environmental protection expenditures, some analysis could be undertaken using a marcoeconomic model. Obviously, the more and the better the data, the more meaningful and useful will be the analysis and the results, although the data requirements for sound macroeconomic analysis are no more demanding than for I/O analysis. The one difference would be that data emphasis for macroeconomic models would be on expenditures. It is worth noting, however, that one approach for macroeconomic model analysis would be to link a macroeconomic model with a satellite model of environmental protection activity. The latter is a detailed, well-developed industry/sector model of a particular activity that interacts with the macroeconomic model, thus allowing analysis of the economic impacts for the economy as a whole and other industries in the macroeconomic model, and simultaneous analysis of environmental protection activity in the satellite model. However, this model construction would require considerable data and, given the dispersion of EP activity across industries and sectors, would pose major problems.

In the case of the GEC model, full specification of an EP industry would require a wide range of data and estimates of relevant parameters.

Given the characteristics of EP activity described above, specifying an EP industry is not very promising. However, if some data and information describing the importance of EP inputs could be developed for each industry, then it might be possible to analyze the impact on such areas as resource allocation within an existing GEC model.

5.4 Analysis that can be done with Existing Data

The two sources of data with the best coverage are the Statistics Canada data on public sector spending on environmental protection, and the DRIE Capital Intentions Survey numbers on the environmental protection capital expenditure of the companies surveyed. The public sector data are comprehensive in coverage and include both capital and operating costs. The private sector data on the other hand, are weak:

- understated, due to the limited number of companies surveyed
- understated, due to the lack of own account and operations and maintenance costs.
- not ideal for impact analysis due to the lack of information concerning what the expenditures were for (equipment, buildings, etc.)

When considering the nature of the economic analysis that could be undertaken, it is important to recognize that it is always possible to undertake some analysis with few and incomplete data. For example, on the basis of the existing data and some heroic assumptions about the gaps, it would be possible to undertake I/O analysis or macroeconomic analysis. However, the results would be questionable and open to severe

criticism, particularly in view of the weakness of private sector data. It is not recommended that such analysis be undertaken using the existing data. In the case of the other types of analysis, the existing data are far too weak and suspect for any useful or meaningful results.

Better data on private sector expenditures will be produced from Statistics Canada's 1985 Capital Expenditure Survey question on pollution abatement expenditures. This will provide good coverage, but still has weaknesses:

- only capital expenditures
- no data on the nature of the commodities purchased

These data will, when published, provide a sounder basis for certain types of analysis. However, again their weaknesses will still leave the results open to criticism.

5.5 Options for Obtaining Additional Data

5.5.1 Industry associations

5.5.1.1 Survey of Purchasers

Large purchasers of EP commodities are generlly well represented by a number of large industry associations. While persons speaking for several associations complained that their members are already "surveyed to death", most were receptive to the idea of a survey designed to elicit useful data on the environmental protection sector, and would be willing to respond to yet another questionnaire, provided that

- it were well-designed,
- it were drawn up in consultation with the associations.

From such a survey, the following kinds of information could be gathered:

- types, quantity and value of EP commodities purchased,
- from whom EP commodities were purchased,
- changes and trends in EP commodity purchases
- reasons for purchases of EP commodities: economic or regulatory,
- use of commodities: capital or current,
- extent of own-account contribution to EP activity,
- economic costs and benefits to firms purchasing EP commodities,
- nature of each firm's EP activity: process redesign or "end of pipe" installation.

A number of associations stated that their staffs, and those of their members, have been considerably reduced in size, and therefore a simple questionnaire would be more welcome because of time constraints.

One or two associations indicated their intention to embark upon such data gathering, but no progress seems to have yet been made in defining a suitable approach.

Most associations contacted expressed a willingness to supply a membership list and endorse the effort if requested to do so.

5.5.1.2 Survey of suppliers

a) The feasibility of developing a list of supplier companies was explored in some detail. In some subsectors, such as consulting engineering, comprehensive lists are freely available; however, most associations do not cover their respective industries fully. It would be necessary to undertake a search for individual lists for this purpose, select suitable candidates and eliminate duplication.

Sources would include trade publications, Statistics Canada lists, conference lists, etc. All individual associations contacted indicated that they would make their membership list available for such an effort.

Company lists could be obtained from Statistics Canada for the approximately twenty industry classes which are expected to include many of the companies which produce EP goods and services. However, since these lists would include many companies not producing environmental protection goods and services, such lists would not be very helpful.

In our view, the generation of a comprehensive and useful listing is essentially an organizational and clerical task. The search should be carried out subsector by subsector, since a wide variety of sources would be used. A list of suggested subsectors was outlined in section 4.1.1.

5.5.1.3 Survey of Suppliers - Conduct-ing a Quantitative Survey

Performing a survey of suppliers of environmental protection equipment would be less straightforward than surveying the large purchasers, (even after completion of the list discussed above) for the following reasons:

- since many of the companies are not organized into associations, specifically dealing with their EP activity the focus and endorsement of an association would not always be available.
- some subsectors, such as recyclers and waste haulers, are characterized by privately-owned companies, who might tend to be reluctant to disclose data,
- for many companies, environmental protection is a small part of their business, and co-operating with a survey may therefore be low priority
- many companies that are specialized in environmental protection are small, and thus may therefore have no data available or staff to collect them.

Nonetheless, based on discussions held with industry representaives a survey appears to be feasible. Data could be gained on:

- current sales, and trends seen
- products, and trends seen
- the companies that are in the EP business, and the level of EP activity
- role of EP activity in their business
- the size of businesses involved in EP
- ownership structure
- production data, such as
  - value added
  - labour and capital intensity
  - profile of labour force
  - material inputs
- motives of purchasers

5.5.1.4 Survey of Suppliers - Conduct-ing a Qualitative Study

An alternative approach to "defining" the environmental protection sector would be to conduct a qualitative study of the industry subsectors by interviewing key individuals in each one. Those interviewed would include:

- individual association personnel (where on associations exists)

- heads of a range of companies (large and small, specialized and nonspecialized),
- key scientists in relevant areas,
- companies with new or unique expertise or technologies.

Such a process could provide information on

- technical advances
- export potential
- a sense of costs and benefits to both the public and to those implementing the changes
- a profile of the industry, including the number and size of companies and their dependence on environmental protection business
- the degree to which the players see their company as part of an "environmental protection industry".

While this type of study would generate hard data on sales and exports only as available, it would provide a sense of the industry structure and of the technical processes involved.

5.5.2 Prospects for Improved Data-gathering by Statistics Canada

There are a number of steps which can be taken to improve the data base. Statistics Canada could be approached to modify existing surveys by asking additional questions.

Several options could be pursued to improve and add to the existing data available from Statistics Canada. These are outlined below.

For expenditure data, consultations with Statistics Canada could be initiated to:

- determine the degree of definitional consistency among the various EP expenditure categories and find ways to improve consistency and data quality (such as defining expenditure categories so that they conform to the EP activity definition presented in this report)
- determine how data on EP operating and maintenance and own-account expenditures by the private sector could be collected
- the addition of questions to Statistics Canada's existing surveys should be explored

For production data, discussions with Statistics Canada could be initiated to:

- determine the feasibility of obtaining data on domestic production, exports and imports of EP commodities by disaggregating existing data in a more appropriate manner, and adding relevant quetions to the Annual Survey of Manufacturers
- determine the feasibility of defining either an EP industry in its SIC system and an EP commodity in its ICC system
- determine whether a list of the Canadian companies which produce EP commodities could be developed

In our opinion it would <u>not</u> be worthwhile to ask Statistics Canada to collect data on the "EP industry". Statistics Canada has a framework within which industries are defined in a hierarchy. This framework must serve many purposes and is not likely to be modified at

this time in order to satisfy the needs for a grouping together of all establishments which produce EP commodities. Within the existing SIC, these commodities are produced by a variety of industries manufacturers, construction firms, service producers, etc. Hence, our recommendations focus on obtaining commodity data from Statistics Canada while respecting its framework. This can be achieved by asking Statistics Canada to develop and elaborate commodity classes for environmental protection goods and services. Where it is desirable to organize data outside this framework, we suggest initiating surveys independently of Statistics Canada.

5.6 Analysis That Could Be Done With Additional Data

The type of data sought will, of course, depend upon the kind of economic analysis desired. Of the several kinds of economic analysis described in the report, full cost-benefit analysis appears beyond research even if additional data were obtained. It is extremely difficult to measure in monetary terms the social value of environmental control. This problem is not unique to EP activity. For most policy issues it is quite possible to quantify the private-economic dimension but almost impossible to meaningfully measure the social dimension.

Turning to the other types of economic analysis, additional data on EP expenditures by broad categories --private sector, public sector, intermediate goods and services, capital formation -- would provide a useful basis for undertaking macro economic modelling analysis. The desired data are not extensive and solid analysis could be undertaken if the data on total

expenditures by each category could be obtained or reasonably estimated. Although macro economic models provide a systematic link between demand -- expenditures and supply -- domestic producers and imports, as indicated above, these linkages are based on relatively aggregate classes of expenditures and industries. Since EP activity is submerged into broad categories and the particular economic characteristics of EP activity may differ significantly from the average measures for the broad categories which encompass EP users and suppliers, the macro economic analysis would be more reliable if additional information on the general supply and production characteristics of EP goods and services as well as on the types of goods and services used within each broad expenditure category was incorporated.

Additional data of the kind desirable for macro economic modelling analysis could be used for input-output analysis. However, the data needs here are more detailed, because the input-output model can be disaggregated to a greater degree in terms of commodities and industries that macro economic models. This is not to say that general and broad data on EP activity cannot be used to undertake input-output analysis, but meaningful analysis requires detailed data on the types and values of EP commodities demanded and supplied. Also, some good information on the characteristics of EP production would add to the usefulness of the analysis.

Short-term surveys could fill the data gaps for macro economic and input-output analysis. However, demand and production technology analysis (DPT) and general equilibrium modelling (GEC) analysis require solid comprehensive and detailed data, usually covering more than just one or a few years of observations. The principle reason is that DPT and GEC analysis

involve direct empirical measurement and estimation of supply and demand characteristics and relationships. Input-output and macro economic analysis can use existing models and any economic analysis of EP activity along these lines can therefore focus directly on how to incorporate EP activity into the model. In contrast, DPT analysis involves directly constructing and estimating models that describe quantitatively the main economic characteristics of EP activity -- be it on the demand or production side. The construction of general equilibrium models is expensive and time consuming. In recent years, however, a number of these models have become available. It is better then to employ an existing model and devote the work effort to incorporating the environmental protection activity information within that model.

The date required for DPT analysis can only come from Statistics Canada and would require Statistics Canada to identify and survey EP activity implicitly over a number of years. This would entail Statistics Canada defining EP commodities -- for purposes of its statistical and data base management system. As argued earlier in the report, as EP production is spread across numerous different industries, it is unlikely that Statistics Canada would define an EP industry or group of EP industries in its SIC classification system. Consequently, even in the long term, the prospects of undertaking GEC analysis appear limited.

6.0 Conclusions

1. The EP industry is not an industry that can be readily identified like the iron and steel industry or the pulp and paper industry. Rather it

is composed of many activities of many firms not all of which derive the greatest share of their revenues from environmental protection activities.

2. It is apparent that in order to put in place an adequate mechanism for ongoing data collection on environmental protection activity in the future, it will be necessary for an in-depth definition to be agreed upon and used by the data-gathering agencies. At present there is no common perception of what constitutes "environmental protection", and consultation will be needed in order to develop a definition which is acceptable to all participants. One concern expressed by industry representatives was the amount of EP embodied in a process change.

3. There are accurate and fairly comprehensive data on EP expenditures by the public sector.

4. Expenditures by the private sector are incomplete and biased. The data currently available include only incomplete estimates of capital expenditures, and omit expenditures on current items such as operating and maintenance, materials and services. Data soon available from the '85 survey will give a better picture of capital expenditure.

5. The above limitations in existing data mean that, while an impact analysis could be done on the basis of these data, the results would be unreliable and susceptable to serious distortions. Nevertheless, it is feasible to collect sufficient additional data to perform a range of economic analyses.

6. So far as further data collection on the expenditure side is concerned, it appears from our discussions with industry representatives that a survey would be a feasible next step in this study. Spokesmen for large associations, whose members are purchasers of environmental protection commodities, were generally supportive of a survey designed to quantify their expenditures, subject to consultations and the development of an acceptable approach. This would provide good data for a defensible impact analysis.

7. There are virually no useful data currently available on the production of EP goods and services. There is no industry classification of producers of EP commodities. Statistics Canada does not identify EP goods and services in its commodity classification system except for a few items. As a result, EP commodities are subsumed in general commodity classifications and there is no attempt by Statistics Canada to define an EP industry classification.

8. Surveying the suppliers of environmental protection commodities to get data on the production of EP goods and services would be more problematic. There is no ready and comprehensive source which could be used for identifying companies in this sector, and therefore, as a first step, a list of companies would have to be compiled. A direct survey of the companies identified could provide useful information. It would be a contribution in any long term effort undertaken by Statistics Canada to define EP commodities, and to develop surveys to gather the appropriate data for economic analyses and policy development.

9. A qualitative survey, taking the form of discussions and interviews with the industry, would ascertain their views on descriptive and non numerical factors, as discussed earlier in the report. This would be the only way of identifying potential exports and products for import substitution.

10. It would be reasonable to encourage and request Statistics Canada to expand and elaborate its commodity classifications to include EP commodity classes. This would require a concerted effort to identify a general commodity catagory of EP goods and services and then to define within this category a comprehensive set of EP commodity classes. However, it would not be productive at this time to press Statistics Canada to create an EP industry class.

7.0 Recommendations

1. The definition put forward in this report provices a basis for consultation between interested groups and agencies with the aim of agreeing upon a definition to be used in the future for all data gathering in this field. It is recommended that such consultation take place.

2. One of the major difficulties in generating useful private sector data on environmental protection activity has been that of isolating capital expenditures for environmental protection from those which are incurred for other purposes. Guidance for industries is needed in this connection, and this should be part of the consultations with data-

gathering agencies, and the subject of discussion with the industry associations.

3. Consultations with Statistics Canada should take place to encourage them to improve their collection of data from the private sector by expanding and elaborating their commodity classification to include EP commodity classes and defining and breaking down the pollution abatement and control category on their capital expenditure survey.

4. In view of the significance of own-account expenditures, particularly on operation and maintenance, a special comprehensive survey of users is recommended as the only method of measuring the full impact of environmental protection on Canada's economy.

5. A qualitative survey of the industry as discussed in section 5.5.1.4 is recommended to gather descriptive information on its structure, markets and potential.

6. A long term data collection plan should be devised to produce improved EP data that could be employed to support a broad range of economic and policy analyses. This plan should be developed in conjunction with Statistics Canada and other data gathering agencies. Since it is probable that data collection may involve special surveys as well as Statistics Canada's regular surveys, and that the data will be used for policy as well as economic analysis, an appropriate agency to act as the ongoing repository and compiler of the data base, should be identified.

Appendix A

Annotated Bibliography

Cook, Alvin A. Jr., Environmental Protection, Environ. Sci. Technol., Vol. 20, No. 6, 1986.

This article, written by an economist with Management Information Services, summarizes their study.

Department of the Environment (1981), The Pollution Abatement Industry in Canada, Internal Document.

This DOE report examines the structure, size and future prospects of the pollution abatement industry in Canada. To provide a sense of the size of the industry, the author collated capital expenditure data from Statistics Canada and the Department of Industry, Trade and Commerce (now Regional Industrial Expansion) for the years 1974-78. Since these data sources, plus others, are reviewed in Chapter 5 of this report, the reader is referred to this Chapter for an updated summary of the expenditure data available from these sources.

Donnan, J.A. et al., Abatement Cost Functions: The "Workhorse" of Environmental Management, Ontario Ministry of the Environment, Policy and Planning Branch, November 1986.

This paper focuses on cost functions for technological applications using cost estimates. The issue of overall expenditures is not addressed, and there are no data on actual expenditures.

Federation of Associations on the Canadian Environment (FACE), The Water Pollution Industry: A Strategic Profile, prepared for the Environmental Protection Service, Environment Canada, Ottawa, October 1984, 190 pages.

This report presents the findings of a nation-wide survey of companies working in the water pollution control industry (including detailed case studies of four companies), together with an analysis of associated data from Statistics Canada. Its purpose was to provide a basis for future strategy options, including characterization of the water and water pollution control industry, and five- and ten-year projections of sector activity. The report attempts to determine the contribution to the Canadian economy, to analyze the role of government in both stimulating and regulating activity, and to identify the sources of information available to the industry as a whole.

While the data, which are exhaustively analyzed, concern mainly capital expenditures, they also include expenditures on services, such as consulting and laboratory services, as well as research and development costs. However, the study covers only water and water pollution control, i.e. the provision of water,

processing of wastewater, and the manufacture and marketing of associated equipment and technology. The foreign as well as the domestic market in water and wastewater processing technology is covered, though the number of respondents was relatively small. The scope of the industry is addressed by analyzing the total value of construction generated, government expenditures and the total value of the manufacturing sector.

Federation of Associations on the Canadian Environment (1981), National Inventory of Municipal Waterworks and Wastewater Systems in Canada, Ottawa.

This report is the third in a series which intends to provide a continuing and accurate account of municipal water and wastewater systems in Canada. The information is collected by a survey questionnaire and consolidated in a computer database management system called MUNDAT. Although some of the information on wastewater treatment systems, such as the number and type of plants by province, may be useful in qualitative analyses of public sector environmental protection activity, none of the expenditure or production data available in this report could be used in quantitative analyses.

Geddes, R.S., Abatement of Acid Gas Emissions: Phase I, prepared for Environment Canada, SKM Consulting Ltd., 1985.

This report includes preliminary capital and current cost estimates for five wet scrubbing flue gas desulphurization processes: limestone with forced oxidation, wet lime with forced oxidation, wet lime with sludge disposal, magnesium oxide with regeneration and magnesium oxide with forced oxidation. These estimates were put together for the purpose of assessing the costs and benefits of alternative control technologies for reducing or eliminating acid rain precursors originating from sour gas processing and tar sands upgrading plants in Alberta. The report deals with the costs of the installations only, and contains no data on actual expenditures on pollution abatement.

Glenn, Bill, Pollution Abatement Creates Employment, Probe Post, No. 19, March 1982.

This article surveys the data available in Canada, the U.S.A. and a number of European countries on the impacts of environmental protection. The author confirms the fact that in Canada, comprehensive data are available only on public sector expenditures.

Jolicoeur, G. (1979), Etude Summaire du Marche-Quebecois dans le Domaine Equipments Antipollution, Internal Memorandum of the Quebec Government.

This memorandum provides estimates of the projected demand for pollution abatement equipment for the years 1974-84 in the province of Quebec. These estimates are largely based on Departmental information and supplemented by oral interviews with industry representatives. Estimates of similar quality could probably be produced again, but such estimates would not be very reliable.

Joubert, G. (1980), Les Implications du Programme Quebecois D'Assainissement de l'Eau, Prepared for the Association Quebecoise des Techniques de l'Eau.

The data in this report were collected to estimate the impact of a proposed province-wide wastewater treatment program on the Quebec economy and the capacity of Quebec's industry to absorb this increased demand. The data were obtained from three sources: through surveys sent to many of the firms involved in the wastewater treatment business, from in-depth personal interviews with representatives of some of these firms and from data on wastewater plants built in the United States obtained from the Environmental protection Agency. Both capital and current expenditures are estimated to perform the economic impact analysis. Although these estimates could be up-dated using the methodology outlined in this paper, the data would not be very reliable.

Laikin, R. and J.A. Donnan, Expenditures on Environmental Protection in Canada, 1980-84, in G.C. Ruggieri, The Canadian Economy: Problems and Policies, 3rd Ed., Educational Publishing Co., Toronto, 1987.

This recently published paper reviews Statistics Canada publications issued between 1980 and 1984 and discusses federal, provincial and local government expenditures and associated employment statistics as reported in a number of publications, and private sector data identified in corporate taxation and construction statistics. The authors conclude that, while public sector data contain operating and maintenance as well as capital expenditures, private sector data cover only a portion of capital expenditures.

MacLaren, James F. Ltd., Potential for Expansion of the Pollution Equipment Manufacturing Industry in Canada, Willowdale, Ontario, 1979.

This report analyzes the market status of the Canadian pollution control equipment industry (PCEMI) in 1978. For the purposes of analysis, the market is broken into the fields of:

water and wastewater	$254 million	(69%)
solid waste	$53 million	(14%)
air pollution	$49 million	(13%)
noise abatement	$13 million	(4%).

Of these expenditures, 81.5% were undertaken by governments.

The report notes a lack of primary data; the market estimates are made on the basis of information gained from 275 verbal interviews. Lists of suppliers were compiled on the basis of James F. MacLaren Ltd.'s experience, supplemented by trade magazine listings.

The industry was found to be dominated by sales and application operations that subcontract the fabrication of assembly work to Canadian shops. Costs associated with potable water treatment are included. No data on actual expenditures are given. Operating costs are excluded, as well as capital costs other than those incurred for equipment. No significant export activity in the pollution control field is identified, but, given that the world market is currently growing at a rate of 40% per year, the major potential for the PCEMI is seen to be in the export area.

The attitude of purchasers was pinpointed as a problem, in that there seems to be a preference for foreign-made equipment, and a lack of awareness of the capabilities of Canadian manufacturers.

Management Information Services, Inc., Economic and Employment Benefits of Investments in Environmental Protection, Washington, D.C., 1986

This report, while of interest as a possible model for Canada, contains only U.S. data, and is therefore not relevant to this study.

McIntyre, A.J., Environmental Policy and Technical Change in the Pulp and Paper Industry, Environment Canada, Corporate Planning Group, Policy Directorate, September 1982.

This is a discussion paper on the interaction between environmental protection and innovation in the pulp and paper industry, and includes no data on expenditures.

Noll, K.E., C.N. Haas and J.W. Patterson, Recovery, Recycle and Reuse of Hazardous Waste, Hazardous Waste Management, Vol. 36, No. 10, October 1986.

This article explores the technical and economic aspects of various waste recovery processes, but presents no data on actual expenditures.

OECD (1985), The Macroeconomic Impact of Environmental Expenditure, Paris, France: OECD Publications Office.

This study makes use of environmental protection expenditure data for six OECD countries -- Austria, Finland, France, Netherlands, Norway, and U.S. -- to assess the effect of these expenditures on economic growth, inflation, trade and productivity. Data are supplied on all EP expenditures by the public and private sector, and for current and capital purposes. Data are available for all six countries except Norway which provides data only on investments in mining and manufacturing. The data came from many different sources, both official and unofficial. Because the quality of the data varies considerably among the six countries, no general statement is offered regarding data quality.

Ross, P.S. and Partners, Market Potential for Pollution Abatement Equipment, report prepared for the Quebec Department of Industry and Commerce, June, 1975.

As its title indicates, this report is concerned solely with market potential, and the data are in the form of estimates of future capital expenditures on pollution abatement; no actual expenditures are reported.

Smith, R.E. (1978), The Pollution Control Equipment Industry in Ontario: Historical Performance and Potential, and Possibilities of Import Substitution, Ontario Ministry of the Environment.

This report, prepared by the Program Planning and Evaluation Branch of the Ontario Ministry of the Environment, contains estimates of capital expenditures made by firms in Ontario to acquire and install end-of-line air and water pollution control equipment. In addition, it includes expenditures by the Ontario Provincial Government and municipalities within Ontario on water and sewage treatment facilities. The data came from estimates of costs reported on applications for certificates of approval; any missing data was imputed. The cost estimates provided on application forms are available from the date the certificates of approval were required. Certificates of approval are required for any process causing emissions to the atmosphere or discharges to a provincial watercourse by the Environmental Protection Act (1971) and the Ontario Water Resources Act (1970), respectively.

Task Force on Environmental Protection Technologies, report presented to the Minister of State for Science and Technology, Ottawa, February 1983, 31 pages.

The Task Force was composed of members representing a variety of interests, including private industry, unions, utilities, industry associations, universities and laboratory service companies. Its terms of reference were to identify opportunities for Canada in the area of environmental protection technology, and to examine appropriate means of commercialization. Information was gathered in the form of written submissions and discussions with representatives of producers and users of environmental protection technology, public interest groups and government throughout the country. The report is therefore purely narrative and contains no hard data. Since the report is four years old, its usefulness as an overview is limited.

Appendix B

Tables Noted in Text

TABLE 1: AVAILABLE EXPENDITURE DATA FROM STATISTICS CANADA

STATISTICS CANADA CATALOGUES	ITEMS COVERED	RELEVANT BREAK-DOWNS OF THE DATA	SOURCE OF DATA
64-201 Annual Construction in Canada	• Construction work purchased for sewage systems, disposal plants and connections	- by three levels of government and the private sector - type of construction: new or repair - for each of the provinces[1]	- approximately 90% of data comes from Capital Expenditure Survey; remainder is estimated - large sample size means coverage is thought to be quite good
68-202 Annual Consolidated Government Finance	• Consolidated government expenditure on: - sewage collection and disposal - garbage and waste collection and disposal - pollution control - other environment	- consolidated expenditures of all levels of governments - consolidated expenditures of provincial and local governments broken down by province	- data are taken from the catalogues listed below: 68-204, 68-207, 68-211
	• Local government expenditure on: - sewage collection and disposal - gargage and waste collection and disposal - other environment	- for each of the provinces - distribution between current and capital expenditure	- main sources of data are the annual reports compiled by provincial departments of Municipal Affairs and Education
68-207 Annual Provincial Government Finance	• Provincial government expenditure on: - pollution control - other environment	- for each of the provinces[1] - distribution between goods and services and transfers to other levels of government	- data are derived from the public accounts of the governments and from the audited financial statements of their agencies
68-211 Annual Federal Government Finance	• Federal government expenditure on: - sewage collection and disposal - pollution control - other environment	- distribution between expenditures on goods and services and transfer payments	- data sources include the printed estimates, Public Accounts of Canada, budget speeches, published financial reports on those entities not reported within Public Accounts, and the departments and agencies of the federal government
61-208 Annual Corporation Taxation	• Private sector capital expenditure for air and water pollution control equipment	- by major industry groups	- data obtained from claims for tax deductions under accelerated capital cost allowances provision - these data represent minimum capital expenditures on pollution control equipment
88-206E Annual Federal Scientific Activities	• Department of Environment expenditure on science and technology activities for: - environmental protection		- data from Main Estimates of budgetary expenditures by program

Note: [1] Information is not currently published but is collected by Statistics Canada.

TABLE 2: BREAKDOWN OF AVAILABLE DATA FROM STATISTICS CANADA BETWEEN CURRENT AND CAPITAL EXPENDITURES

	Total Expenditures			Capital Expenditures			Operating and Maintenance Expenditures		
	Local	Prov.	Fed.	Local	Prov.	Fed.	Local	Prov.	Fed.
PUBLIC SECTOR									
Construction work purchased for sewage systems disposal plants and connections[1]				X	X	X			
Expenditure on sewage collection and disposal[2]	X	X	X	X			X		
Expenditure on garbage and waste collection and disposal[2]	X	X	X	X			X		
Expenditure on pollution control[2]	X	X	X	X			X		
Expenditure on other environment[2]	X	X	X	X			X		
Expenditure on science and technology activities for environmental protection[3]			X						

Notes:
1. Category on the 1984 Capital Expenditure Survey. The 1985 Survey will include a category for pollution abatement and control expenditure.
2. The definition of this item is found in Statistics Canada, The System of Government Financial Statistics, 1984, p. 83.
3. See Federal Scientific Activities, 1986, p. 33 for an account of what is included in this item.

TABLE 2A: PRIVATE SECTOR EXPENDITURE DATA

Private Sector	Source of Data
Capital Expenditure Data	
- Air Pollution Equipment	ACCA
- Water Pollution Equipment	ACCA
- Other Equipment	0
- General	DRIE SURVEY
- Construction Work Purchased for Sewage Systems, Disposal Plants and Connections	StatsCan
- Services	0
- R&D	0
Operating Expenditures Data	
- Materials	0
- Labour	0
- Services	0

TABLE 3: AVAILABLE PRODUCTION DATA FROM STATISTICS CANADA

SIC DATA BY CATALOGUE	INDUSTRY CLASSES FOR WHICH DATA ARE PUBLISHED - 1980 SIC	COMMODITIES OR SERVICES RELATED TO ENVIRONMENTAL PROTECTION ACTIVITY INCLUDED IN SIC INDUSTRY CLASSES	DATA AVAILABLE
42-214 Annual Other Machinery and Equipment Industries	* 3191 Compressor, Pump and Industrial Fan	- centrifugal, reciprocating and rotary pumps	- value of shipments
		- axial industrial fans and blowers	- value of shipments
		- centrifugal industrial fans and blowers	- value of shipments
		- compressors, fans, blowers and vacuum pumps	- value of shipments
	* 3199 Other Machinery and Equipment	- pollution equipment	- no data published
		- water, waste and sewage treatment equipment	- value of shipments
		- industrial fans and blowers	- value of shipments
		- pumps and compressors	- value of shipments
		- air filters, bag collection unit	- value of shipments
		- other air purification and dust collection equipment and parts	- value of shipments
46-218 Annual Clay Products Industries	* 3511 Clay Products (Domestic Clay)	- clay sewer pipes and fittings	- no data published
	* 3512 Clay Products (Imported Clay)	- clay sewer pipes and fittings	- no data published
46-219 Annual Cement Industries	* 3541 Concrete Pipe	- concrete sewer pape	- no data published
	* 3544 Other Concrete Products	- concrete septic tanks	- no data published
46-216 Annual Miscellaneous Chemical Industries	* 3799 Other Chemical Products	- septic tank chemical preparations	- no data published
31-211 Annual Products Shipped by Canadian Manufacturers	* 307 Compressors, fans, blowers and vacuum pumps	- 5071 air compressors	
		- 50711 stationary air compressors	
		- 5074 industrial fans, blowers, and vacuum pumps	
		- 507411 axial fans and blowers	
		- 507412 centrifugal fans and blowers, n.e.s.	
		- 507419 industrial fans and blowers, n.e.s.	
		- 5075 parts for fans and blowers	
	* 308 Pumps	- 508132 centrifugal and sump industrial pumps	
		- 5082 reciprocating pumps	
		- 5083 rotary pumps	
	* 309 Miscellaneous machinery	- 5093 air purification and dust collection equipment and parts	
		- 50931 air purification and dust collection equipment	
	* 762 Water, waste and sewage treatment equipment	- 7268 parts of water, waste and sewage treatment equipment	
		- 7269 water, waste and sewage treatment equipment	
MISCELLANEOUS DATA			
64-210 Annual Special Trades Contracting Industry	* total value of construction output on septic systems		